REMARKS

In the Office action dated February 27, 2002, claims 1 – 9, 12 – 16, 18, and 21 – 29 were rejected and claims 10 – 11, 17, 19 – 20, and 30 – 31 were objected to. In response, Applicants have canceled claims 15, 16, and 18, amended claims 4, 7, 12, 14, 21, 24, and 27 and added new claims 32 – 72 and hereby request further examination and reconsideration of the application in view of the amended and added claims and the below-provided remarks.

I. Objection To Figure 2

Figure 2 was rejected because the splitter/coupler (212) disclosed on the first line of page 9 is not shown in Figure 2. Applicants have corrected Figure 2 and have provided a corrected copy of Figure 2 herein. A corrected copy has also been sent to the patent draftsperson under separate cover.

Figure 2 has been corrected to include the reference number –212--. The reference number was inadvertently left off of Figure 2. The element to which the reference number is added is described in the specification at page 9, lines 4 – 6. Specifically, the specification states that "[t]he passive optical distribution network shown in Fig. 2 has a tree topology that includes a common optical fiber 210 (trunk fiber) and multiple ONU-specific fibers 216 that are connected by a passive optical splitter/coupler 212." Because the element is described and referred to in the specification with the missing reference number, Applicants assert that no new matter has been added.

II. Allowable Subject Matter

Claims 10 – 11, 17, 19 – 20, and 30 – 31

The Office action states that claims 10 – 11, 17, 19 – 20, and 30 – 31 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the

base claim and any intervening claims. (Office action, page 6, item 6) Applicants have added new claims 32 – 61, which are written to include all of the limitations of the respective base claims and any intervening claims as suggested in the Office action. Applicants have also added new claims 62 – 72, which include the limitations of claim 17 into the independent claim 1. A brief description of the new claims is provided below.

New claims 32 – 40

New claim 32 is formed by combining the limitations of claims 1, 9, and 10.

Claims 10 – 11 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claim 10, as filed, depends from claim 9, which depends from claim 1. Applicants have added new claim 32, which is formed by adding the limitations of independent claim 1 and the limitations of dependent claims 9 and 10. Applicants assert that new claim 32 is in an allowable condition.

New claims 33 – 40 depend from new claim 32 and are similar to claims 2 – 8 and 11 as filed. Applicants assert that new claims 33 – 40 are allowable based on an allowable new claim 32.

New claims 41 – 46

New claim 41 is formed by combining the limitations of claims 12 and 17.

Claim 17 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claim 17, as filed, depends from claim 12. Applicants have added new claim 41, which is formed by adding the limitations of independent claim 12 and the limitations of dependent claim 17. Applicants assert that new claim 41 is in an allowable condition.

New claims 41 – 46 depend from new claim 41 and are similar to claims 13, 14, and 18 – 20 as filed. Applicants assert that new claims 41 – 46 are allowable based on an allowable new claim 41.

New claims 47 – 52

New claim 47 is formed by combining the limitations of claims 12 and 19.

Claims 19 – 20 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claim 19, as filed, depends from claim 12. Applicants have added new claim 47, which is formed by adding the limitations of independent claim 12 and the limitations of dependent claim 19. Applicants assert that new claim 47 is in an allowable condition.

New claims 48 – 52 depend from new claim 47 and are similar to claims 13, 14, 17, 18, and 20 as filed. Applicants assert that new claims 48 – 52 are allowable based on an allowable new claim 47.

New claims 53 – 61

New claim 53 is formed by combining the limitations of claims 21, 29, and 30.

Claims 30 – 31 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claim 30, as filed, depends from claim 29, which depends from claim 21. Applicants have added new claim 53, which is formed by adding the limitations of independent claim 21 and the limitations of dependent claims 29 and 30. Applicants assert that new claim 53 is in an allowable condition.

New claims 54 – 61 depend from new claim 53 and are similar to claims 22 – 28 and 31 as filed. Applicants assert that new claims 54 – 61 are allowable based on an allowable new claim 53.

New claims 62 – 72

New claim 62 is formed by combining the limitations of claims 1 and 17.

Claim 17 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claim 17, as filed, recites "transmitting downstream synchronization markers at constant time intervals." The limitation of claim 17 depends from the method claim 12 and was not included as a limitation in independent claim 1 or any of its dependent claims. Applicants have added new claim 62, which is formed by adding the limitations of independent claim 1 and the limitations of dependent claim 17. The new claim recites a point-to-multipoint optical communications system wherein the OLT transmits "downstream synchronization markers at constant time intervals." Because Applicants have incorporated the limitations of claim 17 into independent claim 1, Applicants assert that new claim 62 should be allowable based on the allowable subject matter included within claim 17.

New claims 63 – 72 depend from new claim 62 and are similar to claims 2 – 11 as filed. Applicants assert that new claims 63 – 72 are allowable based on an allowable new claim 62.

III. Claim Rejections Under 35 U.S.C. 112

Claims 15 and 16

Claim 15 was rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected to, to make and/or use the invention. Claim 15 has been canceled and therefor the rejection is moot. Claim 16, which is dependent on claim 15 has also been canceled.

Claims 4, 7, 14, 24, and 27

Claims 4, 7, 14, 24, and 27 were rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Specifically, the claims were rejected because "the term 'related' is a relative term, which renders the claim indefinite." (Office action page 3, item 3). In order to particularly point out and distinctly claim the subject matter which Applicants regard as the invention, claims 4, 7, 14, 24, and 27 have been amended to recite that the lengths of the variable-length packets include the lengths of the IP datagrams plus packet overhead. Referring specifically to amended claim 4, for example purposes, the amended claim recites that "the lengths of said variable-length downstream packets include the lengths of said IP datagrams plus packet overhead." Support for the amendment is found in the specification at page 10, lines 21 – 31. The cited section of the specification states:

> "The packet controller reads header information from the IP datagrams and generates variable-length packets that include the IP datagrams as the payload. In an embodiment, the length of each variable-length packet is related to the length of the IP datagram that is placed into the payload. That is, <u>if a downstream IP datagram is 100 bytes, then the variable-length packet will include 100 bytes of payload plus the packet overhead (the header and the error detection field) and if the IP datagram is 1,000 bytes then the variable-length packet will include 1,000 bytes of payload plus the packet overhead</u>. In an embodiment in which the packets are formatted according to IEEE 802.3, the maximum length of a packet is 1,518 bytes (1,500 bytes of payload and 18 bytes of packet overhead)." (emphasis added)

As described in the provided citation, the length of a variable-length packet is set by adding the length of an IP datagram and the overhead of a packet, where the IP datagram is the payload of the packet and where the length of the overhead is set by the packet protocol (i.e., 18 bytes for IEEE 802.3 packets). That is, the length of a variable-length packet includes the length of the IP datagram plus packet overhead. In view of the amendments to claims 4, 7, 14, 24, and 27, Applicants assert that these claims particularly point out and distinctly claim the subject matter which Applicants regard as the invention.

IV. Claim Rejections Under 35 U.S.C. 102

Claims 1, 3 – 4, 6 – 7, 12, 14 – 15, 18, 21, 23 – 24, and 26 – 27 were rejected under 35 U.S.C. 102(e) as being unpatentable over Blahut, patent number EP 1,130,841 A1 (hereinafter Blahut). Claims 15, 16, and 18 are canceled and are not addressed herein.

Independent Claims 1, 12, and 21

Claims 1, 12, and 21 were rejected as being unpatentable in view of Blahut. Claims 12 and 21 have been amended to state that the ONU-specific time slots are filled with multiple variable-length upstream packets. Support for the amendment is found in independent claim 1, dependent claim 18, and in the specification at page 14, lines 3 – 11.

Applicants assert that claims 1, 12, and 21 are not anticipated by Blahut because Blahut does not disclose the downstream transmission of variable-length packets or the upstream transmission of multiple variable-length packets within ONU-specific time slots. Applicants' remarks will first address transmissions in the downstream direction followed by transmissions in the upstream direction.

Downstream Transmissions – Blahut discloses a system and method in which downstream data is transmitted in fixed-length packets, specifically in 53-byte ATM cells. With regard to downstream transmissions, Blahut discloses that "all downstream payload data is formatted as ATM cells. Each cell includes 48 bytes of payload with a 5 byte ATM header." (col. 5, lines 48 – 50). That is, Blahut only discloses a system and method in which downstream transmissions are made using fixed-length cells.

In contrast, Applicants recite in claims 1, 12, and 21 that data is transmitted downstream in "variable-length downstream packets." Transmitting data in variable-length downstream packets is depicted in Fig. 4 of Applicants' specification. In particular, Fig. 4 includes an expanded view of a variable-length packet (430) that is for downstream transmission. Because Blahut only discloses

transmitting data downstream in fixed-length ATM cells, while Applicants claim a system and method in which data is transmitted downstream in variable-length packets, Applicants assert that claims 1, 12, and 21 are not anticipated by Blahut.

Upstream Transmissions – Blahut discloses a system and method in which each ONU is allotted one burst (referred to herein as an ONU-specific time slot) per upstream frame to transmit upstream data. Blahut also teaches that the length of each ONU-specific time slot can be varied "as a function of the bandwidth requirements of the end user terminal equipment connected to that ONU as well as the bandwidth requirements of the end user terminal equipment at the other ONUs." (abstract) That is, Blahut discloses that variable-length ONU-specific time slots are used to dynamically allocate upstream bandwidth among the ONUs in the point-to-multipoint network. Blahut further discloses that each of the ONU-specific time slots is filled with a combination of one byte of data per active voice channel and any awaiting fixed-length ATM cells. Specifically, Blahut discloses at column 7, lines 15 – 17, that the data placed within each ONU-specific time slot "contains one byte per active voice channel that is concatenated with digital video and IP data signals, each in ATM format". (emphasis added) That is, even though the lengths of the ONU-specific time slots are variable, all of the packets/cells that are placed in the ONU-specific time slots are fixed-length packets/cells (specifically 53 byte ATM cells). Although the length of the ONU-specific time slots can be varied to meet certain bandwidth needs (variable-length time slots), Blahut does not disclose placing multiple variable-length packets within the ONU-specific time slots.

In contrast, Applicants recite in claims 1, 12, and 21 that the ONU-specific time slots are "filled with multiple variable-length upstream packets." Transmitting data upstream in ONU-specific time slots that are filled with "multiple variable-length upstream packets" is depicted in Fig. 6 of Applicants' specification. In particular, Fig. 6 includes an expanded view of multiple variable-length upstream packets (640 and 642) that are placed within an ONU-specific time slot. As described above, Blahut only discloses ONU-specific time slots that

are filled with fixed-length ATM cells. Filling ONU-specific time slots with fixed-length ATM cells does not disclose the filling of ONU-specific time slots with multiple variable-length packets. Because Blahut only discloses ONU-specific time slots that are filled with fixed-length ATM cells, while Applicants claim a system and method in which data is transmitted upstream in ONU-specific time slots that are filled with multiple variable-length packets, Applicants assert that claims 1, 12, and 21 are not anticipated by Blahut.

In addition to not being anticipated, Applicants assert that claims 1, 12, and 21 are not obvious in view of Blahut because Blahut teaches away from using variable-length packets. Blahut discloses a point-to-multipoint passive optical network (PON) that is connected to a broadband ATM network (114), which in turn is connected to two ATM servers (116 and 117). Specifically Blahut states at column 5, lines 25 – 28 that "[s]ervers connected to <u>the ATM network</u> 114, such as an Internet server 116 and a video server 117, deliver service, <u>in ATM format</u>, onto network 114." (emphasis added) That is, Blahut's system is specifically directed to an ATM network environment, which includes the point-to-multipoint network, the broadband ATM network, and the servers. Because the point-to-multipoint PON is connected to the broadband ATM network, the point-to-multipoint PON uses ATM as the data link layer protocol (i.e., layer 2 as defined by the International Standards Organization (ISO) in the Open System Interconnection (OSI) model) between the OLTs and the ONUs. If Blahut were to modify the disclosed system to utilize variable-length packets as the data link layer protocol between the OLT and the ONUs, the resulting point-to-multipoint PON would not be directly compatible with the broadband ATM network (114). In particular, conversions between the variable-length packets and the 53 byte fixed-length ATM cells would be required for all communications between the OLT (113) and the broadband ATM network (114). The conversions would require additional hardware and/or software that would add cost to the system and that would add processing delay to the transmissions. Because modifying the point-to-multipoint PON disclosed by Blahut to utilize variable-length packets would result in a system that is not directly compatible with the networks to which

the point-to-multipoint PON is connected, Applicants assert that Blahut teaches away from modifying the system of Blahut to utilize variable-length packets. It is well settled that when prior art references teach away from the claimed invention, the references are relevant and persuasive evidence of the patentability of the claimed invention.

Claims 3, 6, 23, and 26

Claims 3, 6, 23, and 26 recite that the variable-length packets include IP datagrams. Applicants assert that these claims are allowable based on the respective base claims.

Claims 4, 7, 14, 24, and 27

Claims 4, 7, 14, 24, and 27, as amended, recite a system and method in which the lengths of the variable-length packets (downstream and/or upstream) include the lengths of the IP datagrams plus packet overhead. Claims 4, 7, 14, 24, and 27 were rejected on the basis that Blahut discloses transmitting IP datagrams. While Blahut does disclose transmitting IP datagrams, the IP datagrams are transmitted using ATM as the underlying protocol. As described above, Blahut discloses a system and method in which data is transmitted in fixed-length packets (i.e., ATM cells). Even in the upstream direction, where the ONU-specific time slots can be varied in length, the data transmitted within the ONU-specific time slots includes only fixed-length packets. It is known that IP datagrams can be transmitted using ATM as the underlying protocol. However, in order to transmit an IP datagram using ATM as the underlying protocol, the IP datagram must be broken into multiple 48 byte segments. The multiple 48 byte segments become the 48 byte payload of multiple 53 byte ATM cells (every 53 byte ATM cell includes 48 bytes of payload and 5 bytes of overhead). Because the ATM protocol uses only 53 byte fixed-length cells to carry all types of packetized data, the length of each fixed-length ATM cell that is carried between the ONUs and the OLT has no relationship to the length of an IP datagram. The length of an IP datagram does effect the number of ATM cells that are generated to carry a particular IP datagram, however, the length of an IP datagram does not

effect the length of each individual ATM cell because the length of each ATM cell is fixed at 53 bytes.

In contrast, claims 4, 7, 14, 24, and 27, as amended, recite a system and method in which the lengths of the variable-length packets (downstream and/or upstream) include the lengths of the IP datagrams plus packet overhead. That is, the length of each variable-length packet is a function of the length of the IP datagram that is carried within the respective packet. Even though Blahut does describe variable-length ONU-specific time slots, Blahut does not disclose the use of variable-length packets or that the length of the variable-length packets includes the lengths of the IP datagrams plus packet overhead. Because Blahut discloses only the use of fixed-length ATM cells, while claims 4, 7, 14, 24, and 27 recite that the lengths of variable-length packets include the lengths of the IP datagrams plus packet overhead, Applicants assert that claims 4, 7, 14, 24, and 27 are not anticipated by Blahut.

V. Claim Rejections Under 35 U.S.C. 103

Claims 2, 5, 8 – 9, 13, 16, 22, 25, and 28 – 29 were rejected under 35 U.S.C. 103(a) as being unpatentable over Blahut.

Claims 2, 5, 13, 16, 22, and 25

Claims 2, 5, 13, 16, 22, and 25 recite a system and method in which the variable-length packets are formatted according to IEEE 802.3. Regarding claims 2, 5, 13, 16, 22, and 25, the Office action states that "Blahut discloses a method and apparatus for TDM/TDMA communication. However, Blahut does not disclose that the variable length upstream and downstream packets are formatted according to IEEE 802.3 standard." The Office action goes on to conclude that "[h]owever, the family of IEEE 802.3 standard is a well-known standard, which is applied in many telecommunication systems," and "[i]t would have been obvious to one having ordinary skill in the art at the time the invention was made to adapt IEEEE 802.3 standard into Blahut's system for economic

reasons since IEEE 802.3 is widely used standard." (Office action page 5, item 5.1)

Applicants assert that claims 2, 5, 13, 16, 22, and 25 are not rendered obvious in view of Blahut because Blahut teaches away from modifying the system disclosed by Blahut to utilize IEEE 802.3 formatted variable-length packets between the OLT and the ONUs. Blahut discloses a point-to-multipoint PON that is connected to a broadband ATM network (114), which in turn is connected to two ATM servers (116 and 117). Specifically Blahut states at column 5, lines 25 – 28 that "[s]ervers connected to the ATM network 114, such as an Internet server 116 and a video server 117, deliver service, in ATM format, onto network 114." That is, Blahut's system is specifically directed to an ATM network environment, which includes the point-to-multipoint network, the broadband ATM network, and the servers. Because the point-to-multipoint PON is connected to the broadband ATM network, the point-to-multipoint PON uses ATM as the data link layer protocol between the OLTs and the ONUs. If Blahut were to modify the disclosed system to utilize IEEE 802.3 formatted variable-length packets as the data link layer protocol between the OLT and the ONUs, the resulting point-to-multipoint PON would not be directly compatible with the broadband ATM network (114). In particular, conversions between the IEEE 802.3 formatted variable-length packets and the 53 byte fixed-length ATM cells would be required for all communications between the OLT (113) and the broadband ATM network (114). The conversions would require additional hardware and/or software that would add cost to the system and that would add processing delay to the transmissions. Because modifying the point-to-multipoint PON disclosed by Blahut to utilize IEEE 802.3 would result in a system that is not directly compatible with the networks to which the point-to-multipoint PON is connected, Applicants assert that Blahut teaches away from modifying the system of Blahut to utilize IEEE 802.3 formatted variable-length packets. It is well settled that when prior art references teach away from the claimed invention, the references are relevant and persuasive evidence of the patentability of the claimed invention.

In further support of the assertion that Blahut teaches away from modifying its disclosed system to utilize IEEE 802.3 variable-length packets, applicants assert that although the IEEE 802.3 standard is well known, the IEEE 802.3 standard was not designed with the quality of service (QoS) features which are inherent in the ATM standard. Blahut teaches that its system is to be used to handle voice and video communications. ATM includes inherent QoS features that are designed to provide voice and video communications of reliable quality. In contrast, the IEEE 802.3 standard does not include equivalent inherent QoS features for supporting voice and video communications of reliable quality. Because the IEEE 802.3 standard does not include the same inherent QoS features as the ATM standard, Applicants assert that Blahut teaches that ATM is the format of choice for its particular point-to-multipoint PON and that it would be undesirable to use a protocol that does not include equivalent inherent QoS features. Again, Applicants assert that Blahut teaches away from using a protocol such as IEEE 802.3 and therefor does not render the claimed invention obvious.

In further support of the assertion that claims 2, 5, 13, 16, 22, and 25 are not rendered obvious in view of Blahut, Applicants point out that at the time of the invention, there was an established and widely accepted standard for point-to-multipoint PONs that is based on the ATM protocol. The standard, known as the full service access network (FSAN) standard, specifies the use of fixed-length ATM cells between the OLTs and ONUs in a point-to-multipoint PON. Applicants assert that adapting the system of Blahut to utilize the IEEE 802.3 protocol does not provide a clear economic advantage, as is suggested in the Office action (page 5, item 5.1) as a motivating factor for making the modification, because the system would not conform with the FSAN standard. That is, modifying the Blahut system to utilize the IEEE 802.3 protocol would result in a system that does not conform to the widely accepted FSAN standard. Because modifying the Blahut system does not provide a clear economic advantage, Applicants assert that the logic cited in the Office action does not meet the threshold for a *prima facie* case of obviousness.

Claims 8 and 28

Claims 8 and 28 include limitations that recite using packets that are formatted according to IEEE 802.3. Applicants assert that the remarks provided directly above apply equally to these claims.

Claims 9 and 29

Claims 9 and 29 recite packet fragment buffers. Applicants assert that these claims are allowable based on allowable base claims.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached pages are captioned "**VERSION WITH MARKINGS TO SHOW CHANGES MADE**." Applicants respectfully request reconsideration of the claims in view of the amendments and remarks made herein. A notice of allowance is earnestly solicited.

Respectfully submitted,

Mark A. Wilson

Mark A. Wilson
Reg. No. 43,994
Date: August 12, 2002

Wilson & Ham
PMB: 348
2530 Berryessa Road
San Jose, CA 95132
Telephone: (925) 249-1300

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

WHAT IS CLAIMED IS:

1. A point-to-multipoint optical communications system comprising:

an optical line terminal (OLT); and

a plurality of optical network units (ONUs) connected to said OLT by a passive optical network in which downstream data is transmitted from said OLT to said ONUs over said passive optical network and upstream data is transmitted from said ONUs to said OLT over said passive optical network;

said OLT transmitting downstream data over said passive optical network in variable-length downstream packets;

said ONUs transmitting upstream data over said passive optical network within ONU-specific time slots utilizing time division multiplexing, wherein said ONU-specific time slots are filled with multiple variable-length upstream packets.

2. The system of claim 1 wherein said variable-length downstream packets are formatted according to IEEE 802.3.

3. The system of claim 1 wherein said variable-length downstream packets include Internet protocol (IP) datagrams.

4. (amended) The system of claim 3 wherein the lengths of said variable-length downstream packets ~~are related to~~ include the lengths of said IP datagrams plus packet overhead.

5. The system of claim 1 wherein said variable-length upstream packets are formatted according to IEEE 802.3.

6. The system of claim 1 wherein said variable-length upstream packets include Internet protocol (IP) datagrams.

7. (amended) The system of claim 6 wherein the lengths of said variable-length upstream packets ~~are related to~~ include the lengths of said IP datagrams plus packet overhead.

8. The system of claim 1 wherein:

said variable-length downstream packets and said variable-length upstream packets are formatted according to IEEE 802.3; and

said downstream data and said upstream data include Internet protocol (IP) datagrams.

9. The system of claim 1 wherein:

said OLT includes a fragment buffer for storing packet fragments that have been transmitted upstream from said ONUs; and

said ONUs include fragment buffers for storing packet fragments that are to be transmitted upstream from said ONUs.

10. The system of claim 9 wherein said ONUs include fragment logic for:

splitting a variable-length upstream packet into first and second packet fragments; and

adding an end-of-packet-fragment code to said first packet fragment and adding a start-of-packet-fragment code to said second packet fragment.

11. The system of claim 10 wherein said OLT includes fragment logic for:

identifying said end-of-packet-fragment code of said first packet fragment;

buffering said first packet fragment in said OLT fragment buffer;

identifying said start-of-packet-fragment code of said second packet fragment; and

reconstructing said variable-length upstream packet from said first and second packet fragments.

12. <u>(amended)</u> A method for exchanging information between an optical line terminal (OLT) and multiple optical network units (ONUs) in a point-to-multipoint passive optical network comprising:

transmitting downstream data from said OLT to said ONUs in variable-length downstream packets;

transmitting upstream data from said ONUs to said OLT in ONU-specific time slots utilizing time division multiplexing to avoid transmission collisions, wherein said ONU-specific time slots are filled with <u>multiple</u> variable-length upstream packets.

13. The method of claim 12 wherein said variable-length downstream and upstream packets are formatted in accordance with the IEEE 802.3 protocol.

14. <u>(amended)</u> The method of claim 12 wherein said variable-length downstream and upstream packets include ~~a header~~ <u>packet overhead</u> and a payload, and wherein the length of each of said variable-length packets ~~is related to~~ <u>includes</u> the length of an Internet protocol (IP) datagram that is included in the payload of <u>each of</u> said variable-length packets <u>plus the packet overhead</u>.

15. <u>(canceled)</u> ~~The method of claim 12 further including steps of:~~

~~inserting downstream Internet protocol (IP) datagrams into said variable-length downstream packets; and~~

~~inserting upstream IP datagrams into said variable-length upstream packets.~~

16. <u>(canceled)</u> ~~The method of claim 15 wherein said variable-length downstream and upstream packets are formatted in accordance with the IEEE 802.3 protocol.~~

17. The method of claim 12 wherein said step of transmitting downstream data includes transmitting downstream synchronization markers at constant time intervals.

18. (canceled) ~~The method of claim 12 wherein said ONU-specific time slots are filled with multiple variable-length packets.~~

19. The method of claim 12 further including the steps of:

splitting a variable-length upstream packet into a first packet fragment and a second packet fragment;

adding an end-of-packet-fragment code to the end of said first packet fragment; and

adding a start-of-packet-fragment code to the start of said second packet fragment.

20. The method of claim 19 further including steps of:

transmitting said first packet fragment upstream in a first ONU-specific time slot;

buffering said second packet fragment for transmission in a second ONU-specific time slot that is different from said first ONU-specific time slot;

buffering said first packet fragment after said first packet fragment is received at said OLT; and

reconstructing said variable-length upstream packet, at said OLT, from said first packet fragment and said second packet fragment.

21. <u>(amended)</u> A point-to-multipoint optical communications system comprising:

an optical line terminal (OLT); and

a plurality of optical network units (ONUs) connected to said OLT by a passive optical network in which downstream data is transmitted from said OLT to said ONUs and upstream data is transmitted from said ONUs to said OLT;

said OLT including means for formatting downstream datagrams into variable-length downstream packets;

each of said ONUs including:

means for formatting upstream datagrams into variable-length upstream packets; and

means for timing the transmission of said variable-length upstream packets to coincide with ONU-specific time slots in order to avoid collisions with upstream packets from other ONUs<u>, wherein said ONU-specific time slots are filled with multiple variable-length upstream packets</u>.

22. The system of claim 21 wherein said variable-length downstream packets are formatted according to IEEE 802.3.

23. The system of claim 21 wherein said downstream datagrams are Internet protocol (IP) datagrams.

24. <u>(amended)</u> The system of claim 23 wherein the lengths of said variable-length downstream packets ~~are related to~~ <u>include</u> the lengths of said IP datagrams <u>plus packet overhead</u>.

25. The system of claim 21 wherein said variable-length upstream packets are formatted according to IEEE 802.3.

26. The system of claim 21 wherein said upstream datagrams are Internet protocol (IP) datagrams.

27. (amended) The system of claim 26 wherein the lengths of said variable-length upstream packets ~~are related to~~ include the lengths of said IP datagrams plus packet overhead.

28. The system of claim 21 wherein:

said variable-length downstream packets and said variable-length upstream packets are formatted according to IEEE 802.3; and

said downstream datagrams and said upstream datagrams are Internet protocol (IP) datagrams.

29. The system of claim 21 wherein:

said OLT includes a fragment buffer for storing packet fragments that have been transmitted upstream from said ONUs; and

said ONUs include fragment buffers for storing packet fragments that are to be transmitted upstream from said ONUs.

30. The system of claim 29 wherein said ONUs include fragment logic for:

splitting a variable-length upstream packet into first and second packet fragments; and

adding an end-of-packet-fragment code to said first packet fragment and adding a start-of-packet-fragment code to said second packet fragment.

31. The system of claim 30 wherein said OLT includes fragment logic for:

identifying said end-of-packet-fragment code of said first packet fragment;

buffering said first packet fragment in said OLT fragment buffer;

identifying said start-of-packet-fragment code of said second packet fragment; and

reconstructing said variable-length upstream packet from said first and second packet fragments.

32. (new) A point-to-multipoint optical communications system comprising:

an optical line terminal (OLT); and

a plurality of optical network units (ONUs) connected to said OLT by a passive optical network in which downstream data is transmitted from said OLT to said ONUs over said passive optical network and upstream data is transmitted from said ONUs to said OLT over said passive optical network;

said OLT transmitting downstream data over said passive optical network in variable-length downstream packets;

said ONUs transmitting upstream data over said passive optical network within ONU-specific time slots utilizing time division multiplexing, wherein said ONU-specific time slots are filled with multiple variable-length upstream packets;

said OLT including a fragment buffer for storing packet fragments that have been transmitted upstream from said ONUs; and

said ONUs including:

fragment buffers for storing packet fragments that are to be transmitted upstream from said ONUs; and

fragment logic for splitting a variable-length upstream packet into first and second packet fragments, adding an end-of-packet-fragment code to said first packet fragment, and adding a start-of-packet-fragment code to said second packet fragment.

33. (new) The system of claim 32 wherein said variable-length downstream packets are formatted according to IEEE 802.3.

34. (new) The system of claim 32 wherein said variable-length downstream packets include Internet protocol (IP) datagrams.

35. (new) The system of claim 34 wherein the lengths of said variable-length downstream packets include the lengths of said IP datagrams plus packet overhead.

36. (new) The system of claim 32 wherein said variable-length upstream packets are formatted according to IEEE 802.3.

37. (new) The system of claim 32 wherein said variable-length upstream packets include Internet protocol (IP) datagrams.

38. (new) The system of claim 37 wherein the lengths of said variable-length upstream packets include the lengths of said IP datagrams plus packet overhead.

39. (new) The system of claim 32 wherein:

said variable-length downstream packets and said variable-length upstream packets are formatted according to IEEE 802.3; and

said downstream data and said upstream data include Internet protocol (IP) datagrams.

40. (new) The system of claim 32 wherein said OLT includes fragment logic for:

identifying said end-of-packet-fragment code of said first packet fragment;

buffering said first packet fragment in said OLT fragment buffer;

identifying said start-of-packet-fragment code of said second packet fragment; and

reconstructing said variable-length upstream packet from said first and second packet fragments.

41. (new) A method for exchanging information between an optical line terminal (OLT) and multiple optical network units (ONUs) in a point-to-multipoint passive optical network comprising:

transmitting downstream data from said OLT to said ONUs in variable-length downstream packets;

transmitting downstream synchronization markers at constant time intervals; and

transmitting upstream data from said ONUs to said OLT in ONU-specific time slots utilizing time division multiplexing to avoid transmission collisions, wherein said ONU-specific time slots are filled with variable-length upstream packets.

42. (new) The method of claim 41 wherein said variable-length downstream and upstream packets are formatted in accordance with the IEEE 802.3 protocol.

43. (new) The method of claim 41 wherein said variable-length downstream and upstream packets include packet overhead and a payload, and wherein the length of each of said variable-length packets includes the length of an Internet protocol (IP) datagram that is included in the payload of each of said variable-length packets plus the packet overhead.

44. (new) The method of claim 41 wherein said ONU-specific time slots are filled with multiple variable-length packets.

45. (new) The method of claim 41 further including the steps of:

splitting a variable-length upstream packet into a first packet fragment and a second packet fragment;

adding an end-of-packet-fragment code to the end of said first packet fragment; and

adding a start-of-packet-fragment code to the start of said second packet fragment.

46. (new) The method of claim 45 further including steps of:

transmitting said first packet fragment upstream in a first ONU-specific time slot;

buffering said second packet fragment for transmission in a second ONU-specific time slot that is different from said first ONU-specific time slot;

buffering said first packet fragment after said first packet fragment is received at said OLT; and

reconstructing said variable-length upstream packet, at said OLT, from said first packet fragment and said second packet fragment.

47. (new) A method for exchanging information between an optical line terminal (OLT) and multiple optical network units (ONUs) in a point-to-multipoint passive optical network comprising:

transmitting downstream data from said OLT to said ONUs in variable-length downstream packets;

transmitting upstream data from said ONUs to said OLT in ONU-specific time slots utilizing time division multiplexing to avoid transmission collisions, wherein said ONU-specific time slots are filled with variable-length upstream packets;

splitting a variable-length upstream packet into a first packet fragment and a second packet fragment;

adding an end-of-packet-fragment code to the end of said first packet fragment; and

adding a start-of-packet-fragment code to the start of said second packet fragment.

48. (new) The method of claim 47 wherein said variable-length downstream and upstream packets are formatted in accordance with the IEEE 802.3 protocol.

49. (new) The method of claim 47 wherein said variable-length downstream and upstream packets include packet overhead and a payload, and wherein the length of each of said variable-length packets includes the length of an Internet protocol (IP) datagram that is included in the payload of each of said variable-length packets plus the packet overhead.

50. (new) The method of claim 47 wherein said step of transmitting downstream data includes transmitting downstream synchronization markers at constant time intervals.

51. (new) The method of claim 47 wherein said ONU-specific time slots are filled with multiple variable-length packets.

52. (new) The method of claim 47 further including steps of:

transmitting said first packet fragment upstream in a first ONU-specific time slot;

buffering said second packet fragment for transmission in a second ONU-specific time slot that is different from said first ONU-specific time slot;

buffering said first packet fragment after said first packet fragment is received at said OLT; and

reconstructing said variable-length upstream packet, at said OLT, from said first packet fragment and said second packet fragment.

53. (new) A point-to-multipoint optical communications system comprising:

an optical line terminal (OLT); and

a plurality of optical network units (ONUs) connected to said OLT by a passive optical network in which downstream data is transmitted from said OLT to said ONUs and upstream data is transmitted from said ONUs to said OLT;

said OLT including means for formatting downstream datagrams into variable-length downstream packets and a fragment buffer for storing packet fragments that have been transmitted upstream from said ONUs;

each of said ONUs including:

means for formatting upstream datagrams into variable-length upstream packets;

means for timing the transmission of said variable-length upstream packets to coincide with ONU-specific time slots in order to avoid collisions with upstream packets from other ONUs;

fragment buffers for storing packet fragments that are to be transmitted upstream from said ONUs; and

fragment logic for:

splitting a variable-length upstream packet into first and second packet fragments; and

adding an end-of-packet-fragment code to said first packet fragment and adding a start-of-packet-fragment code to said second packet fragment.

54. (new) The system of claim 53 wherein said variable-length downstream packets are formatted according to IEEE 802.3.

55. (new) The system of claim 53 wherein said downstream datagrams are Internet protocol (IP) datagrams.

56. (new) The system of claim 55 wherein the lengths of said variable-length downstream packets include the lengths of said IP datagrams plus packet overhead.

57. (new) The system of claim 53 wherein said variable-length upstream packets are formatted according to IEEE 802.3.

58. (new) The system of claim 53 wherein said upstream datagrams are Internet protocol (IP) datagrams.

59. (new) The system of claim 58 wherein the lengths of said variable-length upstream packets include the lengths of said IP datagrams plus packet overhead.

60. (new) The system of claim 53 wherein:

said variable-length downstream packets and said variable-length upstream packets are formatted according to IEEE 802.3; and

said downstream datagrams and said upstream datagrams are Internet protocol (IP) datagrams.

61. (new) The system of claim 53 wherein said OLT includes fragment logic for:

identifying said end-of-packet-fragment code of said first packet fragment;

buffering said first packet fragment in said OLT fragment buffer;

identifying said start-of-packet-fragment code of said second packet fragment; and

reconstructing said variable-length upstream packet from said first and second packet fragments.

62. (new) A point-to-multipoint optical communications system comprising:

an optical line terminal (OLT); and

a plurality of optical network units (ONUs) connected to said OLT by a passive optical network in which downstream data is transmitted from said OLT to said ONUs over said passive optical network and upstream data is transmitted from said ONUs to said OLT over said passive optical network;

said OLT transmitting downstream data over said passive optical network in variable-length downstream packets and downstream synchronization markers at constant time intervals;

said ONUs transmitting upstream data over said passive optical network within ONU-specific time slots utilizing time division multiplexing, wherein said ONU-specific time slots are filled with multiple variable-length upstream packets.

63. (new) The system of claim 62 wherein said variable-length downstream packets are formatted according to IEEE 802.3.

64. (new) The system of claim 62 wherein said variable-length downstream packets include Internet protocol (IP) datagrams.

65. (new) The system of claim 64 wherein the lengths of said variable-length downstream packets includes the lengths of said IP datagrams plus packet overhead.

66. (new) The system of claim 62 wherein said variable-length upstream packets are formatted according to IEEE 802.3.

67. (new) The system of claim 62 wherein said variable-length upstream packets include Internet protocol (IP) datagrams.

68. (new) The system of claim 67 wherein the lengths of said variable-length upstream packets include the lengths of said IP datagrams plus packet overhead.

69. (new) The system of claim 62 wherein:

said variable-length downstream packets and said variable-length upstream packets are formatted according to IEEE 802.3; and

said downstream data and said upstream data include Internet protocol (IP) datagrams.

70. (new) The system of claim 62 wherein:

said OLT includes a fragment buffer for storing packet fragments that have been transmitted upstream from said ONUs; and

said ONUs include fragment buffers for storing packet fragments that are to be transmitted upstream from said ONUs.

71. (new) The system of claim 70 wherein said ONUs include fragment logic for:

splitting a variable-length upstream packet into first and second packet fragments; and

adding an end-of-packet-fragment code to said first packet fragment and adding a start-of-packet-fragment code to said second packet fragment.

72. (new) The system of claim 71 wherein said OLT includes fragment logic for:

identifying said end-of-packet-fragment code of said first packet fragment;

buffering said first packet fragment in said OLT fragment buffer;

identifying said start-of-packet-fragment code of said second packet fragment; and

reconstructing said variable-length upstream packet from said first and second packet fragments.